**Ecology**

**Ecology** (from [Greek](https://en.wikipedia.org/wiki/Greek_language): οἶκος, "house", or "environment"; -λογία, "study of")[[A]](https://en.wikipedia.org/wiki/Ecology#cnote_A) is the branch of [biology](https://en.wikipedia.org/wiki/Biology)[[1]](https://en.wikipedia.org/wiki/Ecology#cite_note-1) which studies the interactions among organisms and their environment. Objects of study include interactions of [organisms](https://en.wikipedia.org/wiki/Organism) with each other and with [abiotic components](https://en.wikipedia.org/wiki/Abiotic_component) of their [environment](https://en.wikipedia.org/wiki/Environment_(biophysical)). Topics of interest include the [biodiversity](https://en.wikipedia.org/wiki/Biodiversity), distribution, [biomass](https://en.wikipedia.org/wiki/Biomass_(ecology)), and [populations](https://en.wikipedia.org/wiki/Population) of organisms, as well as cooperation and competition within and between [species](https://en.wikipedia.org/wiki/Species). [Ecosystems](https://en.wikipedia.org/wiki/Ecosystems) are dynamically interacting systems of [organisms](https://en.wikipedia.org/wiki/Organisms), the [communities](https://en.wikipedia.org/wiki/Community_(ecology)) they make up, and the non-living components of their environment. Ecosystem processes, such as [primary production](https://en.wikipedia.org/wiki/Primary_production), [pedogenesis](https://en.wikipedia.org/wiki/Pedogenesis), [nutrient cycling](https://en.wikipedia.org/wiki/Nutrient_cycling), and [niche construction](https://en.wikipedia.org/wiki/Niche_construction), regulate the flux of energy and matter through an environment. These processes are sustained by organisms with specific life history traits. Biodiversity means the varieties of [species](https://en.wikipedia.org/wiki/Species), [genes](https://en.wikipedia.org/wiki/Gene), and [ecosystems](https://en.wikipedia.org/wiki/Ecosystem), enhances certain [ecosystem services](https://en.wikipedia.org/wiki/Ecosystem_services).

Ecology is not synonymous with [environmentalism](https://en.wikipedia.org/wiki/Environmentalism), natural history, or [environmental science](https://en.wikipedia.org/wiki/Environmental_science). It overlaps with the closely related sciences of [evolutionary biology](https://en.wikipedia.org/wiki/Evolutionary_biology), [genetics](https://en.wikipedia.org/wiki/Genetics), and [ethology](https://en.wikipedia.org/wiki/Ethology). An important focus for ecologists is to improve the understanding of how biodiversity affects ecological function.

Ecology has practical applications in [conservation biology](https://en.wikipedia.org/wiki/Conservation_biology), wetland management, [natural resource management](https://en.wikipedia.org/wiki/Natural_resource_management) ([agroecology](https://en.wikipedia.org/wiki/Agroecology), [agriculture](https://en.wikipedia.org/wiki/Agriculture), [forestry](https://en.wikipedia.org/wiki/Forestry), [agroforestry](https://en.wikipedia.org/wiki/Agroforestry), [fisheries](https://en.wikipedia.org/wiki/Fisheries)), city planning ([urban ecology](https://en.wikipedia.org/wiki/Urban_ecology)), [community health](https://en.wikipedia.org/wiki/Community_health), [economics](https://en.wikipedia.org/wiki/Ecological_economics), [basic](https://en.wikipedia.org/wiki/Basic_science) and [applied science](https://en.wikipedia.org/wiki/Applied_science), and human social interaction ([human ecology](https://en.wikipedia.org/wiki/Human_ecology)). For example, the [*Circles of Sustainability*](https://en.wikipedia.org/wiki/Circles_of_Sustainability) approach treats ecology as more than the environment 'out there'. It is not treated as separate from humans. Organisms (including humans) and [resources](https://en.wikipedia.org/wiki/Resource_(biology)) compose [ecosystems](https://en.wikipedia.org/wiki/Ecosystem)which, in turn, maintain [biophysical](https://en.wikipedia.org/wiki/Biophysics) feedback mechanisms that moderate processes acting on living ([biotic](https://en.wikipedia.org/wiki/Biotic_component)) and non-living ([abiotic](https://en.wikipedia.org/wiki/Abiotic)) components of the planet. Ecosystems sustain life-supporting functions and produce [natural capital](https://en.wikipedia.org/wiki/Natural_capital) like [biomass production](https://en.wikipedia.org/wiki/Biomass) (food, fuel, fiber, and medicine), the regulation of [climate](https://en.wikipedia.org/wiki/Climate), global [biogeochemical cycles](https://en.wikipedia.org/wiki/Biogeochemical_cycles), [water filtration](https://en.wikipedia.org/wiki/Water_filtration), [soil formation](https://en.wikipedia.org/wiki/Soil_formation), erosion control, flood protection, and many other natural features of scientific, historical, economic, or intrinsic value.

The word "ecology" ("Ökologie") was coined in [1866](https://en.wikipedia.org/wiki/1866) by the German scientist [Ernst Haeckel](https://en.wikipedia.org/wiki/Ernst_Haeckel). Ecological thought is derivative of established currents in philosophy, particularly from ethics and politics.[[2]](https://en.wikipedia.org/wiki/Ecology#cite_note-Laferri%C3%A8reStoett2003-2) Ancient Greek philosophers such as [Hippocrates](https://en.wikipedia.org/wiki/Hippocrates) and [Aristotle](https://en.wikipedia.org/wiki/Aristotle)laid the foundations of ecology in their studies on [natural history](https://en.wikipedia.org/wiki/Natural_history). Modern ecology became a much more rigorous [science](https://en.wikipedia.org/wiki/Natural_sciences) in the late 19th century. [Evolutionary](https://en.wikipedia.org/wiki/Evolution) concepts relating to adaptation and [natural selection](https://en.wikipedia.org/wiki/Natural_selection) became the cornerstones of modern [ecological theory](https://en.wikipedia.org/wiki/Theoretical_ecology).

## Hierarchy

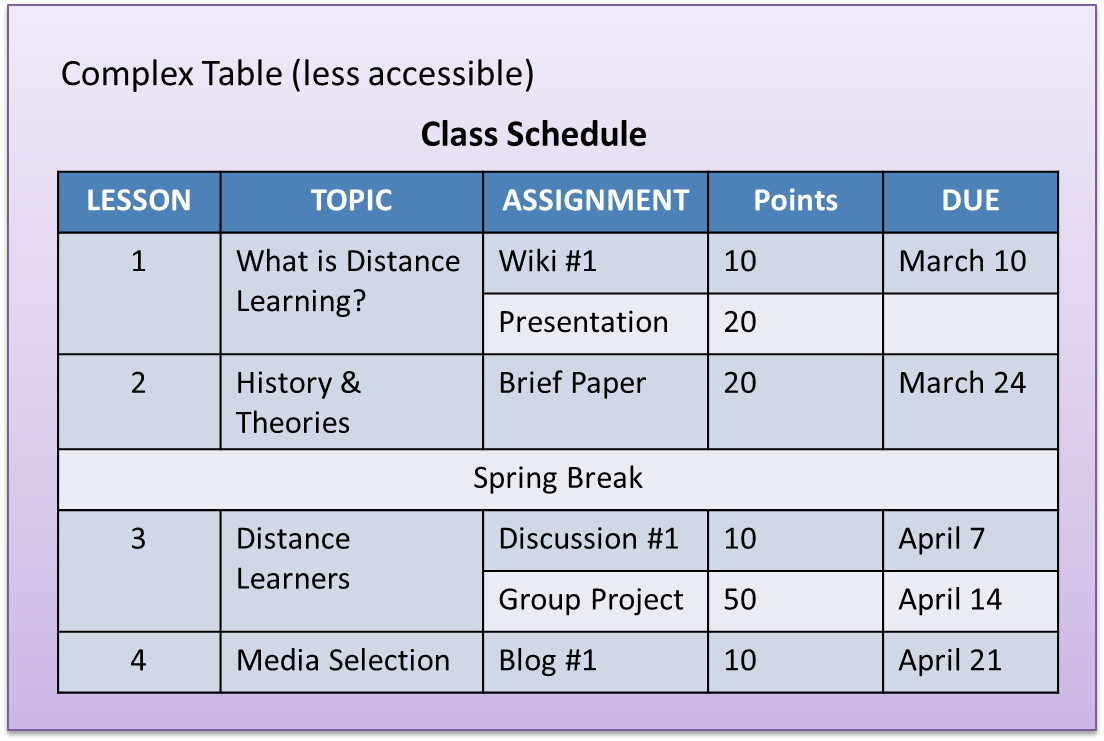
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The scale of ecological dynamics can operate like a closed system, such as aphids migrating on a single tree, while at the same time remain open with regard to broader scale influences, such as atmosphere or climate. Hence, ecologists classify [ecosystems](https://en.wikipedia.org/wiki/Ecosystems)hierarchically by analyzing data collected from finer scale units, such as vegetation associations, climate, and soil types, and integrate this information to identify emergent patterns of uniform organization and processes that operate on local to regional, [landscape](https://en.wikipedia.org/wiki/Landscape), and chronological scales.

To structure the study of ecology into a conceptually manageable framework, the biological world is organized into a [nested hierarchy](https://en.wikipedia.org/wiki/Biological_classification), ranging in scale from [genes](https://en.wikipedia.org/wiki/Gene), to [cells](https://en.wikipedia.org/wiki/Cell_(biology)), to [tissues](https://en.wikipedia.org/wiki/Tissue_(biology)), to [organs](https://en.wikipedia.org/wiki/Organ_(anatomy)), to [organisms](https://en.wikipedia.org/wiki/Organism), to [species](https://en.wikipedia.org/wiki/Species), to [populations](https://en.wikipedia.org/wiki/Population_ecology), to [communities](https://en.wikipedia.org/wiki/Community_(ecology)), to [ecosystems](https://en.wikipedia.org/wiki/Ecosystem), to [biomes](https://en.wikipedia.org/wiki/Biome), and up to the level of the [biosphere](https://en.wikipedia.org/wiki/Biosphere).[[8]](https://en.wikipedia.org/wiki/Ecology#cite_note-Nachtomy01-8) This framework forms a [panarchy](https://en.wikipedia.org/wiki/Panarchy)[[9]](https://en.wikipedia.org/wiki/Ecology#cite_note-Holling01-9) and exhibits [non-linear](https://en.wikipedia.org/wiki/Non-linear)behaviors; this means that "effect and cause are disproportionate, so that small changes to critical variables, such as the number of [nitrogen fixers](https://en.wikipedia.org/wiki/Nitrogen_fixation), can lead to disproportionate, perhaps irreversible, changes in the system properties.

## Biodiversity

Biodiversity (an abbreviation of "biological diversity") describes the diversity of life from genes to ecosystems and spans every level of biological organization. The term has several interpretations, and there are many ways to index, measure, characterize, and represent its complex organization.[[12]](https://en.wikipedia.org/wiki/Ecology#cite_note-Noss90-12)[[13]](https://en.wikipedia.org/wiki/Ecology#cite_note-Scholes08-13)[[14]](https://en.wikipedia.org/wiki/Ecology#cite_note-cardinale2012-14) Biodiversity includes [species diversity](https://en.wikipedia.org/wiki/Species_diversity), [ecosystem diversity](https://en.wikipedia.org/wiki/Ecosystem_diversity), and [genetic diversity](https://en.wikipedia.org/wiki/Genetic_diversity)and scientists are interested in the way that this diversity affects the complex ecological processes operating at and among these respective levels.[[13]](https://en.wikipedia.org/wiki/Ecology#cite_note-Scholes08-13)[[15]](https://en.wikipedia.org/wiki/Ecology#cite_note-Wilson00b-15)[[16]](https://en.wikipedia.org/wiki/Ecology#cite_note-Purvis00-16) Biodiversity plays an important role in [ecosystem services](https://en.wikipedia.org/wiki/Ecosystem_service) which by definition maintain and improve human quality of life.[[14]](https://en.wikipedia.org/wiki/Ecology#cite_note-cardinale2012-14)[[17]](https://en.wikipedia.org/wiki/Ecology#cite_note-Ostfeld09-17)[[18]](https://en.wikipedia.org/wiki/Ecology#cite_note-Tierney09-18) Conservation priorities and management techniques require different approaches and considerations to address the full ecological scope of biodiversity. [Natural capital](https://en.wikipedia.org/wiki/Natural_capital) that supports populations is critical for maintaining [ecosystem services](https://en.wikipedia.org/wiki/Ecosystem_services)[[19]](https://en.wikipedia.org/wiki/Ecology#cite_note-Ceballos02-19)[[20]](https://en.wikipedia.org/wiki/Ecology#cite_note-Palumbi09-20) and species [migration](https://en.wikipedia.org/wiki/Animal_migration) (e.g., riverine fish runs and avian insect control) has been implicated as one mechanism by which those service losses are experienced.[[21]](https://en.wikipedia.org/wiki/Ecology#cite_note-Wilcove08-21) An understanding of biodiversity has practical applications for species and ecosystem-level conservation planners as they make management recommendations to consulting firms, governments, and industry



Habitat

The habitat of a species describes the environment over which a species is known to occur and the type of community that is formed as a result.[[24]](https://en.wikipedia.org/wiki/Ecology#cite_note-Whittaker73-24) More specifically, "habitats can be defined as regions in environmental space that are composed of multiple dimensions, each representing a biotic or abiotic environmental variable; that is, any component or characteristic of the environment related directly (e.g. forage biomass and quality) or indirectly (e.g. elevation) to the use of a location by the animal."[[25]](https://en.wikipedia.org/wiki/Ecology#cite_note-Beyer10-25):745 For example, a habitat might be an aquatic or terrestrial environment that can be further categorized as a [montane](https://en.wikipedia.org/wiki/Montane_ecosystem) or [alpine](https://en.wikipedia.org/wiki/Alpine_tundra) ecosystem. Habitat shifts provide important evidence of competition in nature where one population changes relative to the habitats that most other individuals of the species occupy. For example, one population of a species of tropical lizards (*Tropidurus hispidus*) has a flattened body relative to the main populations that live in open savanna. The population that lives in an isolated rock outcrop hides in crevasses where its flattened body offers a selective advantage. Habitat shifts also occur in the developmental life history of amphibians, and in insects that transition from aquatic to terrestrial habitats. [Biotope](https://en.wikipedia.org/wiki/Biotope) and habitat are sometimes used interchangeably, but the former applies to a community's environment, whereas the latter applies to a species' environment.[[24]](https://en.wikipedia.org/wiki/Ecology#cite_note-Whittaker73-24)[[26]](https://en.wikipedia.org/wiki/Ecology#cite_note-Schoener75-26)[[27]](https://en.wikipedia.org/wiki/Ecology#cite_note-Vitt97-27)

Additionally, some species are [ecosystem engineers](https://en.wikipedia.org/wiki/Ecosystem_engineer), altering the environment within a localized region. For instance, beavers manage water levels by building dams which improves their habitat in a landscape.

## Niche

Definitions of the niche date back to 1917,[[30]](https://en.wikipedia.org/wiki/Ecology#cite_note-Wiens05-30) but [G. Evelyn Hutchinson](https://en.wikipedia.org/wiki/G._Evelyn_Hutchinson) made conceptual advances in 1957[[31]](https://en.wikipedia.org/wiki/Ecology#cite_note-Hutchinson57-31)[[32]](https://en.wikipedia.org/wiki/Ecology#cite_note-Hutchinson57b-32) by introducing a widely adopted definition: "the set of biotic and abiotic conditions in which a species is able to persist and maintain stable population sizes."[[30]](https://en.wikipedia.org/wiki/Ecology#cite_note-Wiens05-30):519The ecological niche is a central concept in the ecology of organisms and is sub-divided into the *fundamental* and the *realized* niche. The fundamental niche is the set of environmental conditions under which a species is able to persist. The realized niche is the set of environmental plus ecological conditions under which a species persists.[[30]](https://en.wikipedia.org/wiki/Ecology#cite_note-Wiens05-30)[[32]](https://en.wikipedia.org/wiki/Ecology#cite_note-Hutchinson57b-32)[[33]](https://en.wikipedia.org/wiki/Ecology#cite_note-Begon05-33) The Hutchinsonian niche is defined more technically as a "[Euclidean](https://en.wikipedia.org/wiki/Euclidean_space) [hyperspace](https://en.wikipedia.org/wiki/N-dimensional_space) whose *dimensions* are defined as environmental variables and whose *size* is a function of the number of values that the environmental values may assume for which an organism has *positive fitness*."[[34]](https://en.wikipedia.org/wiki/Ecology#cite_note-Hardesty75-34):71

[Biogeographical](https://en.wikipedia.org/wiki/Biogeography) patterns and [range](https://en.wikipedia.org/wiki/Range_(biology)) distributions are explained or predicted through knowledge of a species' [traits](https://en.wikipedia.org/wiki/Trait_(biology)) and niche requirements.[[35]](https://en.wikipedia.org/wiki/Ecology#cite_note-Pearman08-35) Species have functional traits that are uniquely adapted to the ecological niche. A trait is a measurable property, [phenotype](https://en.wikipedia.org/wiki/Phenotype), or [characteristic](https://en.wikipedia.org/wiki/Phenotypic_trait) of an organism that may influence its survival. Genes play an important role in the interplay of development and environmental expression of traits.[[36]](https://en.wikipedia.org/wiki/Ecology#cite_note-Levins80-36) Resident species evolve traits that are fitted to the selection pressures of their local environment. This tends to afford them a competitive advantage and discourages similarly adapted species from having an overlapping geographic range. The [competitive exclusion principle](https://en.wikipedia.org/wiki/Competitive_exclusion_principle) states that two species cannot coexist indefinitely by living off the same limiting [resource](https://en.wikipedia.org/wiki/Resource_(biology)); one will always out-compete the other. When similarly adapted species overlap geographically, closer inspection reveals subtle ecological differences in their habitat or dietary requirements.[[37]](https://en.wikipedia.org/wiki/Ecology#cite_note-Hardin60-37) Some models and empirical studies, however, suggest that disturbances can stabilize the co-evolution and shared niche occupancy of similar species inhabiting species-rich communities.[[38]](https://en.wikipedia.org/wiki/Ecology#cite_note-Scheffer06-38) The habitat plus the niche is called the [ecotope](https://en.wikipedia.org/wiki/Ecotope), which is defined as the full range of environmental and biological variables affecting an entire species